

**What is claim 1 is:**

1. An asynchronous switching mode voltage regulator comprising:

5           an output stage connected between an input voltage and  
          a reference potential for generating an output  
          voltage, said output stage including a switch  
          connected between said input voltage and a phase  
10          node, and an unidirectional current-conducting  
          device connected between said phase node and  
          reference potential;  
          a pulse width modulator responsive to said output  
          voltage for generating a PWM signal; and  
          an adjustable one-shot circuit connected with an  
15          adjustable voltage for generating an adjustable  
          signal at a light loading to adjust an ON duty of  
          said switch.

20          2. The regulator according to claim 1, wherein said  
          unidirectional current-conducting device comprises a diode.

          3. The regulator according to claim 1, wherein said  
adjustable one-shot circuit comprises:  
          a charger;  
25          a flip-flop connected with said PWM signal for generating

said adjustable signal to control said charger to be charged and discharged;

a charging current generator connected with said input voltage and adjustable voltage for providing a charging current to charge said charger to thereby generate a charger output; and

a comparator for comparing said charger output with a reference voltage to generate a reset signal to reset said flip-flop.

4. The regulator according to claim 3, wherein said charging current generator comprises:

a current source connected with said input voltage for generating a first current;

a current mirror having a reference branch connected with said first current and a mirror branch for generating a mirrored current by mirroring said first current; and

a current sink connected with said mirror branch and adjustable voltage for separating a second current from said mirrored current to thereby determine said charging current.

5. The regulator according to claim 4, wherein said first current is proportional to said input voltage.

6. The regulator according to claim 4, wherein said second current is proportional to said adjustable voltage.

5           7. The regulator according to claim 1, wherein said adjustable voltage is proportional to said output voltage.

10           8. A method for efficiency improvement of an asynchronous switching mode voltage regulator including an output stage connected between an input voltage and a reference potential for generating an output voltage, said output stage having a switch connected between said input voltage and a phase node, and an unidirectional current-conducting device connected between said phase node and reference potential, and a pulse width modulator responsive to said output voltage for generating a PWM signal, said method comprising the steps of:

15           generating an adjustable signal upon an adjustable voltage at a light loading; and  
20           adjusting an ON duty of said switch by said adjustable signal.

          9. The method according to claim 8, wherein said step of generating an adjustable signal comprises the steps of:

25           triggering a flip-flop to generate a flip-flop output by said PWM signal;

generating said adjustable signal in response to said  
flip-flop output;  
generating a charging current;  
charging a charger by said charging current and  
5       discharging said charger under control of said  
flip-flop output to thereby generate a charger  
output; and  
comparing said charger output with a reference voltage  
to generate a reset signal to reset said flip-flop.

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10. The method according to claim 9, wherein said step  
of generating a charging current comprises the steps of:

generating a first current proportional to said input  
voltage;

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generating a mirrored current by mirroring said first  
current; and

separating a second current proportional to said  
adjustable voltage from said mirrored current for  
determining said charging current.

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11. The method according to claim 8, further comprising  
controlling said adjustable voltage proportional to said output  
voltage.

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12. A synchronous switching mode voltage regulator

comprising:

- an output stage connected between an input voltage and a reference potential for generating an output voltage, said output stage including a high-side switch connected between said input voltage and a phase node, and a low-side switch connected between said phase node and reference potential;
- a pulse width modulator responsive to said output voltage for generating a PWM signal;
- a phase detector for detecting a voltage on said phase node to generate a detection signal to block said low-side switch at a light loading;
- an adjustable one-shot circuit connected with an adjustable voltage for generating an adjustable signal by triggered by said detection signal;
- a control signal responsive to said adjustable signal for adjusting an ON duty of said high-side switch at said light loading; and
- an OFF duty detector for resetting said phase detector when said regulator escapes from said light loading.

13. The regulator according to claim 12, wherein said phase detector comprises:

- a comparator for comparing said voltage on said phase node and reference potential to generate a

comparison signal; and  
a flip-flop responsive to said control signal and  
comparison signal for generating said detection  
signal.

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14. The regulator according to claim 12, wherein said  
adjustable one-shot circuit comprises:

a charger;

10 a flip-flop connected with said PWM signal for generating  
said adjustable signal to control said charger to be  
charged and discharged;

15 a charging current generator connected with said input  
voltage and adjustable voltage for providing a  
charging current to charge said charger to thereby  
generate a charger output; and

a comparator for comparing said charger output with a  
reference voltage to generate a reset signal to reset  
said flip-flop.

20 15. The regulator according to claim 14, wherein said  
charging current generator comprises:

a current source connected with said input voltage for  
generating a first current;

25 a current mirror having a reference branch connected  
with said first current and a mirror branch for

generating a mirrored current by mirroring said  
first current; and  
a current sink connected with said mirror branch and  
adjustable voltage for separating a second current  
5 from said mirrored current to thereby determine  
said charging current.

16. The regulator according to claim 15, wherein said  
first current is proportional to said input voltage.

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17. The regulator according to claim 15, wherein said  
second current is proportional to said adjustable voltage.

18. The regulator according to claim 12, wherein said  
15 OFF duty detector comprises:

a next clock generator for generating a next clock signal  
by delaying said control signal; and  
a reset signal resulted from said control signal and next  
clock signal for resetting said phase detector.

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19. The regulator according to claim 18, wherein said  
next clock generator comprises:

a first flip-flop connected with said control signal for  
generating a first signal;  
25 a second flip-flop connected with a clock signal and said

first signal for generating said next clock signal;  
and  
an AND gate connected with said next clock signal and  
an inverse of said clock signal for generating said  
5 reset signal to reset said first and second flip-flops.

20. A method for efficiency improvement of a  
synchronous switching mode voltage regulator including an output  
stage connected between an input voltage and a reference potential  
10 for generating an output voltage, said output stage having a  
high-side switch connected between said input voltage and a phase  
node, and a low-side switch connected between said phase node  
and reference potential, and a pulse width modulator responsive to  
said output voltage for generating a PWM signal, said method  
15 comprising the steps of:

detecting a voltage on said phase node for generating a  
detection signal to block said low-side switch at a  
light loading;  
generating an adjustable signal upon said detection  
20 signal and an adjustable voltage;  
generating a control signal in response to said  
adjustable signal for adjusting an ON duty of said  
high-side switch at said light loading; and  
generating a reset signal for resetting said detection  
25 signal when said regulator escapes from said light



loading.

21. The method according to claim 20, wherein said step of generating an adjustable signal comprises the steps of:

- 5 triggering a flip-flop to generate a flip-flop output by said PWM signal;  
generating said adjustable signal in response to said flip-flop output;  
generating a charging current;  
10 charging a charger by said charging current and discharging said charger under control of said flip-flop output to thereby generate a charger output; and  
comparing said charger output with a reference voltage  
15 for generating said reset signal to reset said flip-flop.

22. The method according to claim 21, wherein said step of generating a charging current comprises the steps of:

- 20 generating a first current proportional to said input voltage;  
generating a mirrored current by mirroring said first current; and  
separating a second current proportional to said  
25 adjustable voltage from said mirrored current for

determining said charging current.

23. The method according to claim 20, further  
comprising controlling said adjustable voltage proportional to said  
5 output voltage.

24. The method according to claim 20, wherein said step  
of generating a reset signal comprises the steps of:

generating a next clock signal by delaying said control  
10 signal; and  
generating said reset signal upon said control signal and  
next clock signal.